Supporting Information

Towards environmentally friendly processing of ionic liquid based photoresist with a boosted lithography performance

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S1 Details for RCA cleaning method:

Details for RCA cleaning method: A 30% H_2O_2 solution and 98% H_2SO_4 (in a volume ratio of 3:7) were mixed together by adding H_2O_2 to H_2SO_4 slowly, and a silicon wafer was immersed for 45 minutes before being rinsed with deionized water and dried with N_2 gas.

S2 Structure characterization of copolymers

As shown in **Figure S1A**, the FT-IR spectrum basically contains all the characteristic peaks of monomers. The peaks at 3059 cm^{-1} and 1553 cm^{-1} are attributed to the C-H vibration and the C-C skeleton vibration of imidazole ring, respectively. Absorbance at 2956 cm^{-1}, 2862 cm^{-1}, 1462 cm^{-1} and 1388 cm^{-1} ascribe to the characteristic peaks of

methyl and methylene in IL, respectively. And the C=O and C-N stretching vibrational peaks located at 1726 cm^{-1} as well as 1383 cm^{-1} in DMAEMA were also found. Besides, the =C-H stretching vibration and bending vibration of monomers located at 1650 cm^{-1} and 920 cm^{-1} disappeared, indicating that the polymerization occurred completely. For further analyzing the structure of the copolymers, the ^{1}H-NMR of the copolymers were also studied. Different from the sharp peaks exhibited by the monomers, the ^{1}H-NMR spectrum of the copolymers are mostly broader peaks. As shown in **Figure S1B**, the broad peak around 7.76 ppm was attributable to the imidazole ring of IL, and the other protons on the alkyl chain of the IL are located at 4.2 ppm, 1.9 ppm, 1.4 ppm, 1.0 ppm, respectively. The signals at 4.1 ppm and 2.7 ppm correspond to protons of the methylene in DMAEMA and the broad peak at 2.3 ppm indicate protons of methyl groups attached to the nitrogen atom.

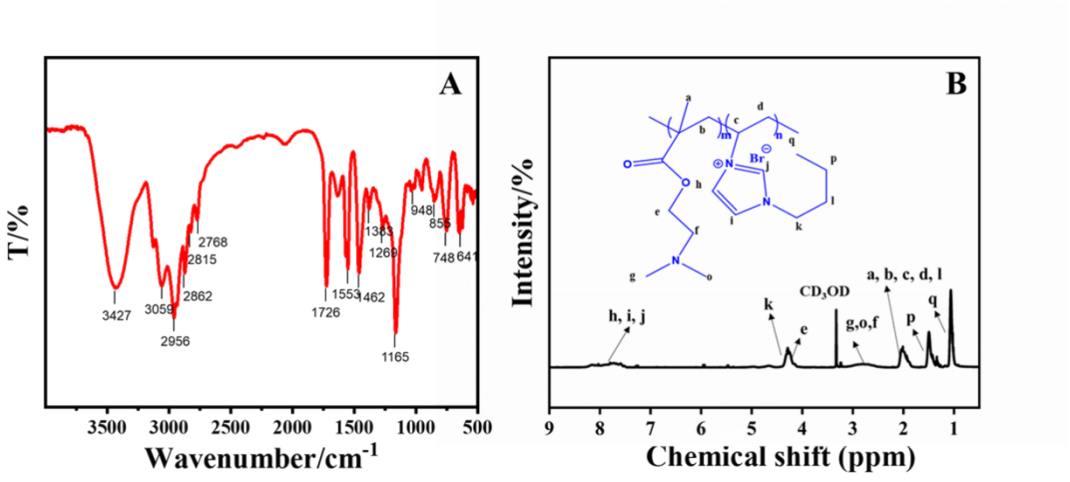

Figure S1. Structure characterization of the synthesized copolymers. A) FT-IR spectrum, B) ^{1}H-NMR spectrum in CD_3OD

S3 Soft bake temperature optimization

The soft bake temperature was screened by controlling other lithography process

conditions, and the results are shown in Figure S2. When the temperature is low, especially 60°C and 80°C, the film surface is not smooth and there are more burrs, the pattern effect is poor. When the temperature is increased to 90°C, this phenomenon is improved by the film surface becomes flat, this phenomenon is further increased to 100 °C, so 90°C is the best soft bake temperature.

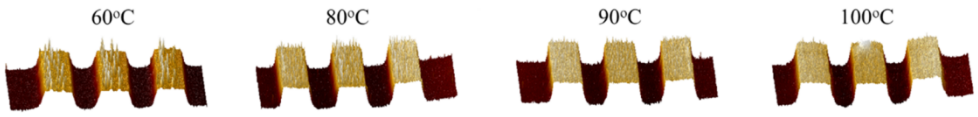

Figure S2： AFM images of patterning pre-baked at different temperature

S4 Post exposure bake temperature optimization

Similarly, the post exposure bake temperature was optimized. When the baking temperature was set to 90°C, the edges of the pattern showed smooth surfaces, which was not ideal for lithography. When the temperature is raised to 110°C, the edges of the lithographic pattern become angular, and this phenomenon does not change at further increasing the temperature. Considering the thermal stability of the photoresist, the lower after-baking temperature is the most appropriate.

Figure S3：AFM images of patterning post-baked at different temperature

S5 AFM image of photoresist with different IL addition

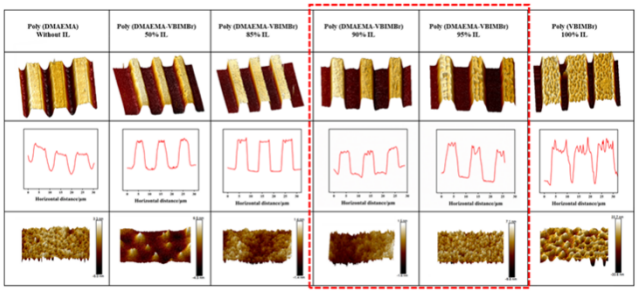

Figure S4. AFM image of photoresist with different IL addition.